

## CLAIMS

What is claimed is:

1. A method for identifying computer network protocols used to encapsulate data in a protocol data unit, which comprises the steps of:
  - receiving the protocol data unit, wherein the protocol data unit comprises data and multiple encapsulation protocol patterns; and
  - while there remains at least one stage for which the protocol data unit is to be searched, iteratively performing:
    - selecting one of the remaining stages, and
    - while there remains at least one search pattern of the selected stage for which the protocol data unit is to be searched, iteratively performing:
      - selecting one of the remaining search patterns, and
      - searching the protocol data unit for the selected search pattern.
2. The method as recited in claim 1, which further comprises the steps of:
  - prior to the while there remains at least one stage iterative loop:
    - assigning a group indicator for at least one pre-defined group of search patterns, wherein the group comprises at least one sub-set which comprises at least one preselected search pattern, wherein

8 the preselected search pattern identifies at least one preselected  
network protocol used to encapsulate data; and

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initializing the group indicator to specify that at least one sub-set  
12 is present in the expected locations in the protocol data unit; and

14 after the while there remains at least one search pattern of the selected  
stage for which the protocol data unit is to be searched iterative loop:

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when all search patterns associated with each sub-set of the group  
18 for the selected stage are absent from the expected locations in the  
protocol data unit, setting the group indicator to specify that all  
20 sub-sets of that group are absent from the protocol data unit.

3. The method as recited in claim 2, which following the method step  
2 searching the protocol data unit for the selected search pattern further  
comprises the step of:

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after the while there remains at least one stage iterative loop:

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when at least one of the sub-sets is present in the expected  
8 locations in the protocol data unit, placing the protocol data unit  
in a buffer.

4. The method as recited in claim 1, wherein the method step searching the  
2 protocol data unit for the selected search pattern comprises the steps of:

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while there remains at least one part of the search pattern of the selected  
stage for which the protocol data unit is to be searched, iteratively  
6 performing:

8 selecting one of the remaining un-searched parts of the selected  
search pattern, and

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searching the protocol data unit for the selected part of the  
12 selected search pattern.

5. The method as recited in claim 4, which further comprises the steps of:

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when the method step searching the protocol data unit for the selected part  
4 of the selected search pattern fails to find the selected part in the protocol  
data unit,

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exiting the while there remains at least one part of the search  
8 pattern of the selected stage for which the protocol data unit is to  
be searched iterative loop and

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exiting the while there remains at least one search pattern of the  
12 selected stage for which the protocol data unit is to be searched  
iterative loop.

6. The method as recited in claim 1, which following the method step  
2 selecting one of the remaining search patterns further comprises the steps  
of:

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when there remains at least one additional search pattern of the selected  
6 stage for which the protocol data unit is to be searched,

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selecting at least one of the additional remaining search patterns,  
and

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in parallel with the method step of searching the protocol data unit

12 for the selected search pattern, searching the protocol data unit for  
the additional selected search pattern.

7. The method as recited in claim 6, wherein the parallel method steps of  
2 searching the protocol data unit for the selected search pattern and of  
searching the protocol data unit for the additional selected search pattern  
4 comprise the steps of:

6 while there remains at least one part of the selected search pattern of the  
selected stage for which the protocol data unit is to be searched and at  
8 least one part of the additional selected search pattern of the selected stage  
for which the protocol data unit is to be searched, iteratively performing:

10 selecting one of the remaining un-searched parts of the selected  
12 search pattern,

14 selecting one of the remaining un-searched parts of the additional  
selected search pattern,

16 searching the protocol data unit for the selected part of the  
18 selected search pattern, and

20 in parallel with the method step of searching the protocol data unit  
for the selected part of the selected search pattern, searching the  
22 protocol data unit for the selected part of the additional selected  
search pattern;

24 otherwise, while there remains at least one part of the selected search  
26 pattern of the selected stage for which the protocol data unit is to be  
searched, iteratively performing:

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selecting one of the remaining un-searched parts of the selected  
search pattern, and

searching the protocol data unit for the selected part of the  
selected search pattern; and

otherwise, while there remains at least one part of the additional selected  
search pattern of the selected stage for which the protocol data unit is to  
be searched, iteratively performing:

selecting one of the remaining un-searched parts of the additional  
selected search pattern, and

searching the protocol data unit for the selected part of the  
additional selected search pattern.

8. The method as recited in claim 7, which further comprises the steps of:

when the method step searching the protocol data unit for the selected part  
of the selected search pattern fails to find the selected part of the selected  
search pattern in the protocol data unit and when the parallel method step  
of searching the protocol data unit for the selected part of the additional  
selected search pattern fails to find the selected part of the additional  
selected search pattern in the protocol data unit,

exiting the while there remains at least one part of the selected  
search pattern of the selected stage for which the protocol data  
unit is to be searched and at least one part of the additional  
selected search pattern of the selected stage for which the protocol  
data unit is to be searched iterative loop;

16 otherwise when the method step searching the protocol data unit for the  
selected part of the selected search pattern fails to find the selected part  
18 of the selected search pattern in the protocol data unit,

20 exiting the while there remains at least one part of the selected  
search pattern of the selected stage for which the protocol data  
22 unit is to be searched iterative loop; and

24 otherwise when the method step searching the protocol data unit for the  
selected part of the additional selected search pattern fails to find the  
26 selected part of the additional selected search pattern in the protocol data  
unit,

28 exiting the while there remains at least one part of the additional  
30 selected search pattern of the selected stage for which the protocol  
data unit is to be searched iterative loop.

9. A storage medium readable by a protocol identification apparatus,  
2 tangibly embodying a computer program of instructions executable by the  
protocol identification apparatus to perform method steps for identifying  
4 computer network protocols used to encapsulate data in a protocol data  
unit, the steps comprising:

6 receiving the protocol data unit, wherein the protocol data unit comprises  
8 data and multiple encapsulation protocol patterns; and

10 while there remains at least one stage for which the protocol data unit is  
to be searched, iteratively performing:

12 selecting one of the remaining stages, and  
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while there remains at least one search pattern of the selected stage for which the protocol data unit is to be searched, iteratively performing:

selecting one of the remaining search patterns, and

searching the protocol data unit for the selected search pattern.

10. The storage medium as recited in claim 9, the steps further comprising:

prior to the while there remains at least one stage iterative loop:

assigning a group indicator for at least one pre-defined group of search patterns, wherein the group comprises at least one sub-set which comprises at least one preselected search pattern, wherein the preselected search pattern identifies at least one preselected network protocol used to encapsulate data; and

initializing the group indicator to specify that at least one sub-set is present in the expected locations in the protocol data unit; and

after the while there remains at least one search pattern of the selected stage for which the protocol data unit is to be searched iterative loop:

when all search patterns associated with each sub-set of the group for the selected stage are absent from the expected locations in the protocol data unit, setting the group indicator to specify that all sub-sets of that group are absent from the protocol data unit.

11. The storage medium as recited in claim 10, wherein following the step

2 searching the protocol data unit for the selected search pattern, the steps  
further comprising:

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after the while there remains at least one stage iterative loop:

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when at least one of the sub-sets is present in the expected  
8 locations in the protocol data unit, placing the protocol data unit  
in a buffer.

12. The storage medium as recited in claim 9, wherein the step searching the  
2 protocol data unit for the selected search pattern comprising the steps of:

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while there remains at least one part of the search pattern of the selected  
stage for which the protocol data unit is to be searched, iteratively  
6 performing:

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selecting one of the remaining un-searched parts of the selected  
search pattern, and

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searching the protocol data unit for the selected part of the  
12 selected search pattern.

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13. The storage medium as recited in claim 12, the steps further comprising:

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when the method step searching the protocol data unit for the selected part  
4 of the selected search pattern fails to find the selected part in the protocol  
data unit,

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exiting the while there remains at least one part of the search  
8 pattern of the selected stage for which the protocol data unit is to  
be searched iterative loop and

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10 exiting the while there remains at least one search pattern of the  
selected stage for which the protocol data unit is to be searched  
12 iterative loop.

14. The storage medium as recited in claim 9, wherein following the method  
2 step selecting one of the remaining search patterns, the steps further  
comprising:

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when there remains at least one additional search pattern of the selected  
6 stage for which the protocol data unit is to be searched,

8 selecting at least one of the additional remaining search patterns,  
and

10 in parallel with the method step of searching the protocol data unit  
12 for the selected search pattern, searching the protocol data unit for  
the additional selected search pattern.

15. The storage medium as recited in claim 14, wherein the parallel method  
2 steps of searching the protocol data unit for the selected search pattern  
and of searching the protocol data unit for the additional selected search  
4 pattern comprise the steps of:

6 while there remains at least one part of the selected search pattern of the  
selected stage for which the protocol data unit is to be searched and at  
8 least one part of the additional selected search pattern of the selected stage  
for which the protocol data unit is to be searched, iteratively performing:

10 selecting one of the remaining un-searched parts of the selected  
12 search pattern,

14 selecting one of the remaining un-searched parts of the additional  
selected search pattern,

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18 searching the protocol data unit for the selected part of the  
selected search pattern, and

20 in parallel with the method step of searching the protocol data unit  
for the selected part of the selected search pattern, searching the  
22 protocol data unit for the selected part of the additional selected  
search pattern;

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26 otherwise, while there remains at least one part of the selected search  
pattern of the selected stage for which the protocol data unit is to be  
searched, iteratively performing:

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30 selecting one of the remaining un-searched parts of the selected  
search pattern, and

32 searching the protocol data unit for the selected part of the  
selected search pattern; and

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36 otherwise, while there remains at least one part of the additional selected  
search pattern of the selected stage for which the protocol data unit is to  
be searched, iteratively performing:

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40 selecting one of the remaining un-searched parts of the additional  
selected search pattern, and

42 searching the protocol data unit for the selected part of the  
additional selected search pattern.

16. The storage medium as recited in claim 15, the steps further comprising:

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when the method step searching the protocol data unit for the selected part of the selected search pattern fails to find the selected part of the selected search pattern in the protocol data unit and when the parallel method step of searching the protocol data unit for the selected part of the additional selected search pattern fails to find the selected part of the additional selected search pattern in the protocol data unit,

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exiting the while there remains at least one part of the selected search pattern of the selected stage for which the protocol data unit is to be searched and at least one part of the additional selected search pattern of the selected stage for which the protocol data unit is to be searched iterative loop;

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otherwise when the method step searching the protocol data unit for the selected part of the selected search pattern fails to find the selected part of the selected search pattern in the protocol data unit,

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exiting the while there remains at least one part of the selected search pattern of the selected stage for which the protocol data unit is to be searched iterative loop; and

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otherwise when the method step searching the protocol data unit for the selected part of the additional selected search pattern fails to find the selected part of the additional selected search pattern in the protocol data unit,

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exiting the while there remains at least one part of the additional selected search pattern of the selected stage for which the protocol data unit is to be searched iterative loop.

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17. An apparatus for identifying those computer network protocols used to encapsulate data in a protocol data unit, comprising:

a control circuit, wherein the control circuit is capable of receiving the protocol data unit and is capable of obtaining at least one search pattern for each of multiple stages, wherein each search pattern identifies one of the network protocols used to encapsulate data; and

a pattern comparator, wherein the pattern comparator is connected to the control circuit, wherein the pattern comparator is capable of receiving the protocol data unit from the control circuit, wherein the control circuit is capable of successively selecting individual stages, and wherein for the selected stage the pattern comparator is capable of receiving at least one search pattern for the selected stage from the control circuit and of separately searching the protocol data unit for the received search pattern.

18. The apparatus as recited in claim 17, wherein the pattern comparator is capable of separately searching the protocol data unit for part of the received search pattern.

19. The apparatus as recited in claim 17, wherein the pattern comparator is capable of separately searching the protocol data unit for multiple received search patterns in parallel.

20. The apparatus as recited in claim 17, further comprising a first accumulator, wherein the first accumulator is connected to the pattern comparator and is capable of accumulating results from searches of the selected stage.

21. The apparatus as recited in claim 20, further comprising:

2 a mapping circuit, wherein the mapping circuit is connected to the first  
4 first accumulator and wherein the mapping circuit maps the contents of the  
first accumulator against a preselected group of search patterns.

22. The apparatus as recited in claim 21, further comprising a second  
2 accumulator, wherein the second accumulator is connected to the  
mapping circuit and is capable of accumulating results from maps of the  
4 first accumulator for each stage against the preselected group of search  
patterns.

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